GLAST Science Support Center Detailed Design Peer Review

I. Overview

J.P. Norris

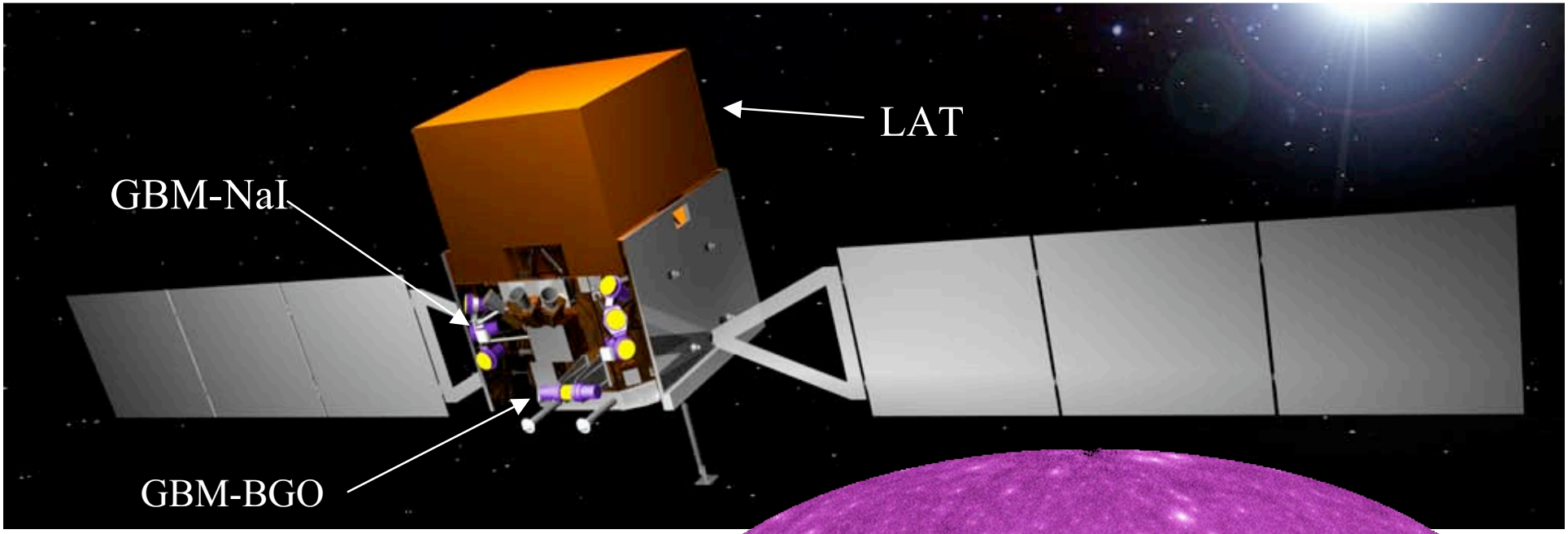
I. Overview

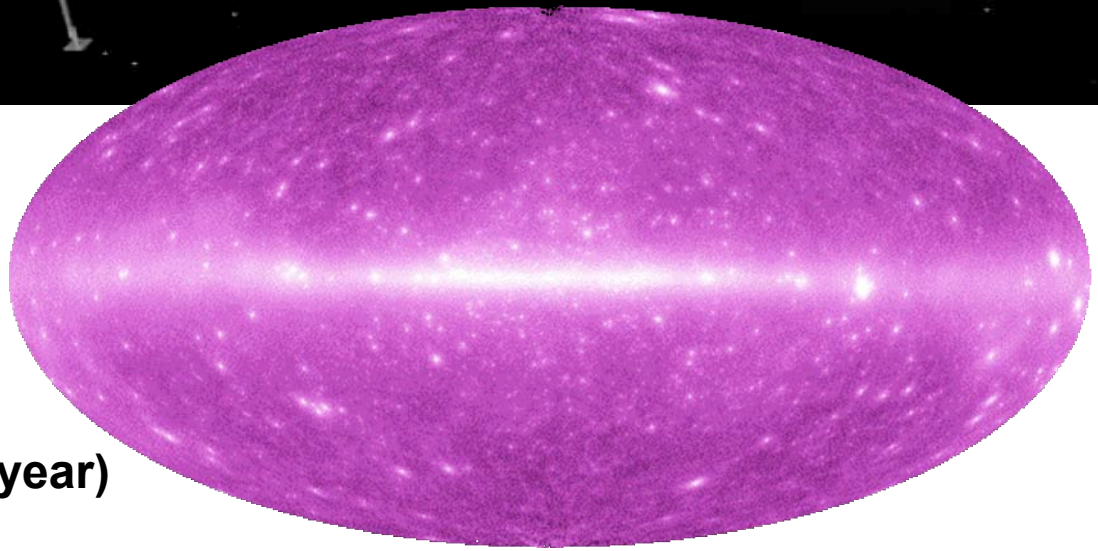
1. Purposes of Review
2. GLAST
   - LAT — Main Instrument
   - GBM — GRB Context Instrument
3. Observations & Data
4. Mission Phases
5. Mission Architecture
6. GSSC-Centric Communications / Data Flow
7. GSSC Computer Architecture
8. Δ's on Requirements, Design
9. RFA chart from 1st Peer Review
10. Outline & Schematic of Sections, II. → VIII.

Peer Review Purposes

- At the 1st GSSC Peer Review (11/24/04) the need for a 2nd Peer Review was apparent; this was requested by the review panel (RFA #1). The need for a second round of reviews was also apparent at the peer reviews of other ground system elements.
- The purpose of this peer review is to establish that the GSSC design is at a CDR-level: *The detailed design — including schedule — is in place, and we can demonstrate that each milestone captures the motivating requirement.*
- The Ground System Design Review (8/18-19) will build on the individual peer reviews of the ground system elements.
- The materials for this review may be found at:
  http://glast.gsfc.nasa.gov/ssc/dev/Peer_Review_0407/
- Ground system RFAs may be issued by the peer review panel and GLAST-related personnel in attendance, specifically for GSSC areas.

The GLAST Mission





LAT (> 100 MeV, 1year)

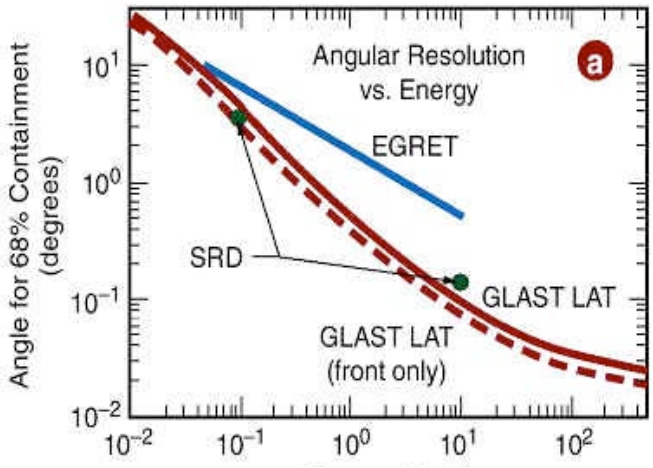
GLAST Instruments, Spacecraft

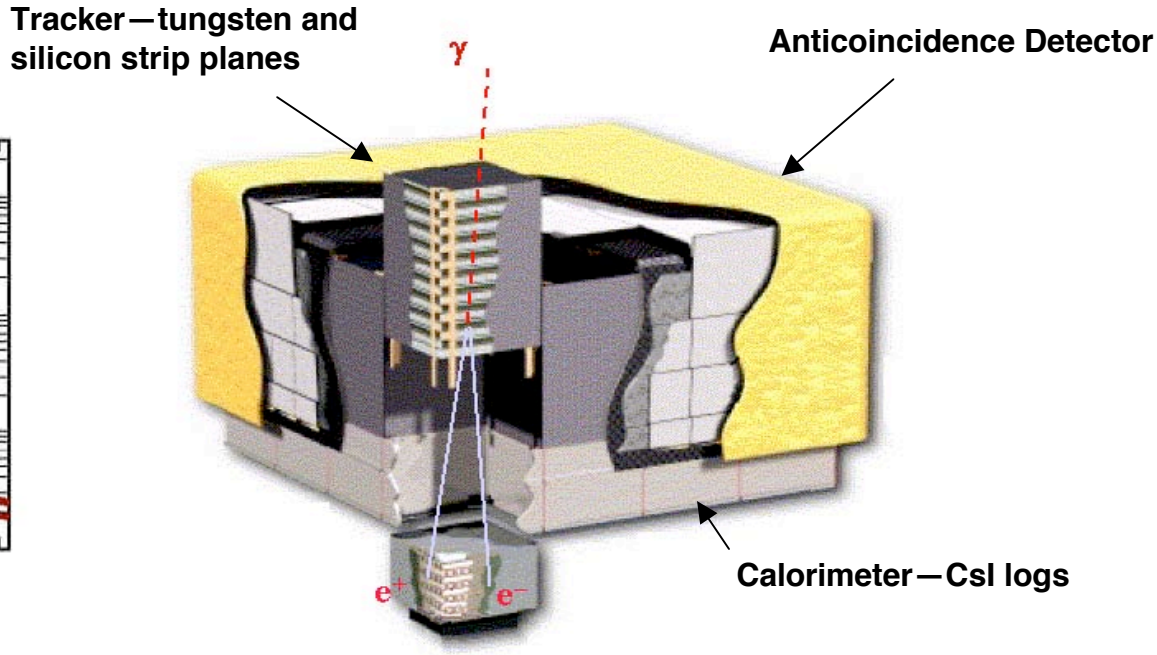
- Gamma-ray Large Area Space Telescope (GLAST)
  — successor to *CGRO* instruments EGRET and BATSE.
- The Large Area Telescope (LAT) — GLAST's main instrument
  The LAT is a NASA-DOE collaboration with foreign contributions.
  PI: Peter Michelson (Stanford & SLAC)
- The GLAST Burst Monitor (GBM) — GRB context instrument
  The GBM is a MSFC-German collaboration.
  PI: Chip Meegan (NSSTC)
- Spacecraft will be built by Spectrum-Astro.
- Scheduled launch is February 2007, into low earth orbit.
- Minimum mission is 5 years, with a goal of 10+ years!

Large Area Telescope (LAT)

The LAT is a pair conversion telescope.

- A γ-ray is converted to an e^+e^- pair in one of 16 tungsten planes.
- The leptons are tracked by 19 pairs (X-Y) of silicon strip planes.
- The silicon strips and 8 planes of CsI "logs" measure the energy.
- Plastic anti-coincidence scintillator tiles provide first line of defense against charged particles.





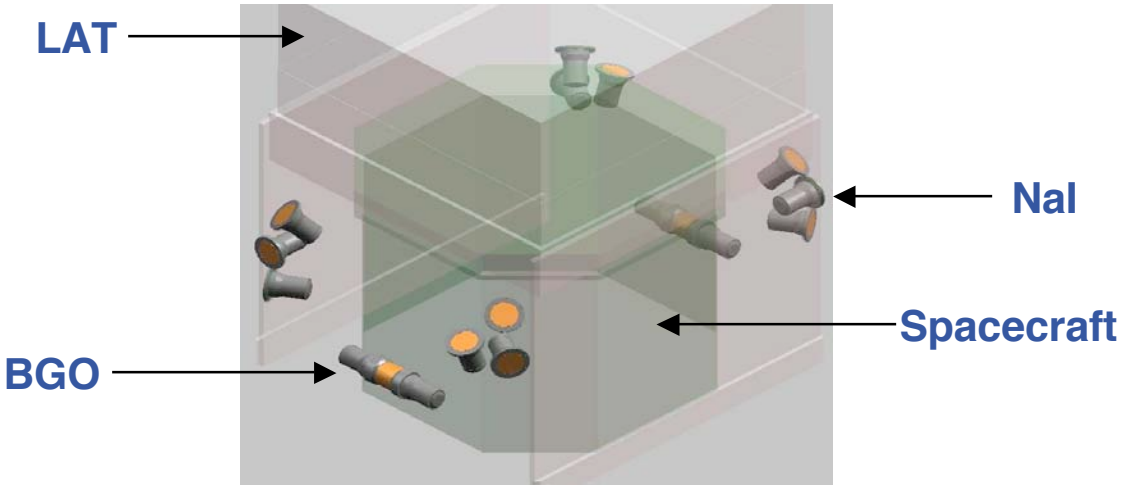
LAT Performance Characteristics

- Energy Range: < 20 MeV to > 300 GeV
- $\Delta E/E < 10\%$ on axis for 0.1–10 GeV.
- Peak effective area ~ 10000 cm^2
- FOV ~ 2.4 sr (_ peak A_{eff} at 52° off axis)
- 1γ angular resolution $< 3.5°$ @ 0.1 GeV, $< 0.12°$ @ 10 GeV
- Only a few events of the ~ 300 s^{-1} events telemetered to Earth will be photons.
- Deadtime: ~ 20 μs
- In normal, scanning operation GLAST will survey the sky; thus most data will be taken at different angles to the LAT.

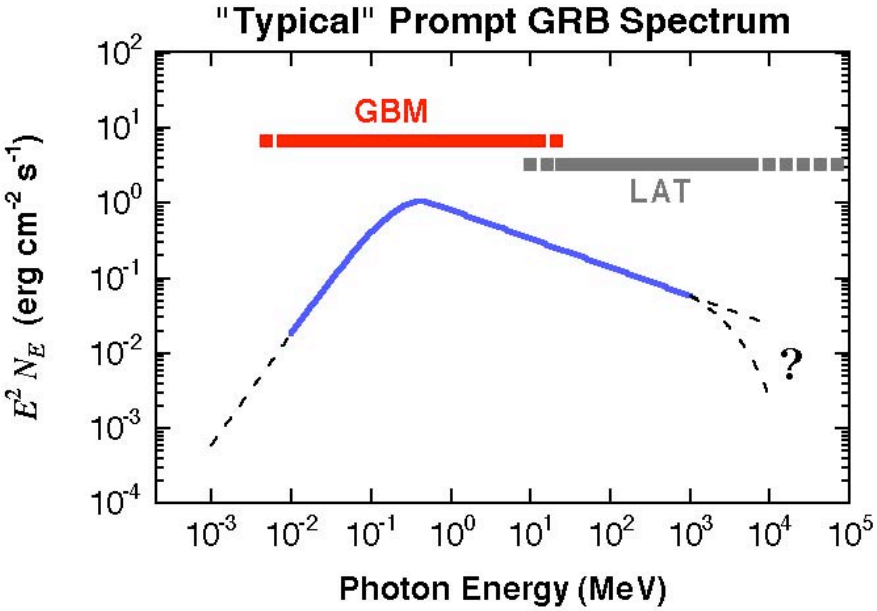
Large field of view and large effective area mean that the LAT will be > 30 × more sensitive than EGRET.

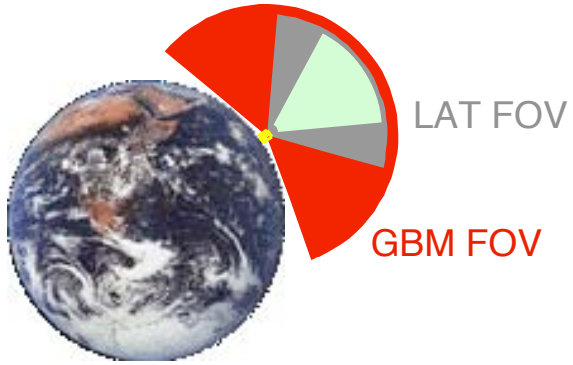
GLAST Burst Monitor (GBM)

- Purpose:
  - Detect gamma-ray bursts: different rate triggers
  - Localize bursts: both on-board and on the ground, by comparing rates in the detector array
  - Provide low energy context for the LAT observations: GBM + LAT provide spectral coverage from ~ 10 keV to ~ 300 GeV — 7.5 decades!
- 12 NaI(Tl) detectors (5 in. dia.) — < 10 keV to ~ 1 MeV
- 2 BGO detectors (5 in. long, 5 in. dia.) — to > 25 MeV



LAT & GBM Spectral Coverage, FOV





Observations

- GLAST can point "anytime, anywhere:"
  - The orientation of the Sun relative to solar panels and radiators is a physical constraint, but does not affect pointing flexibility.
  - Observing efficiency dictates keeping the Earth out of the central part of the field-of-view (FOV).
- Two basic observing modes:
  - Survey mode—the LAT scans the sky continuously. For uniform exposure over short time periods, the spacecraft will rock every orbit ~ 30° about the zenith direction perpendicular to the orbital plane.
  - Pointed mode—the LAT points at a source.
    - Also, the LAT may point autonomously, e.g. in response to a GRB alert.
- The LAT FOV is very large and source fluxes are low. Therefore, survey mode will usually be the most efficient mode to build up exposure over the sky.

Data Levels

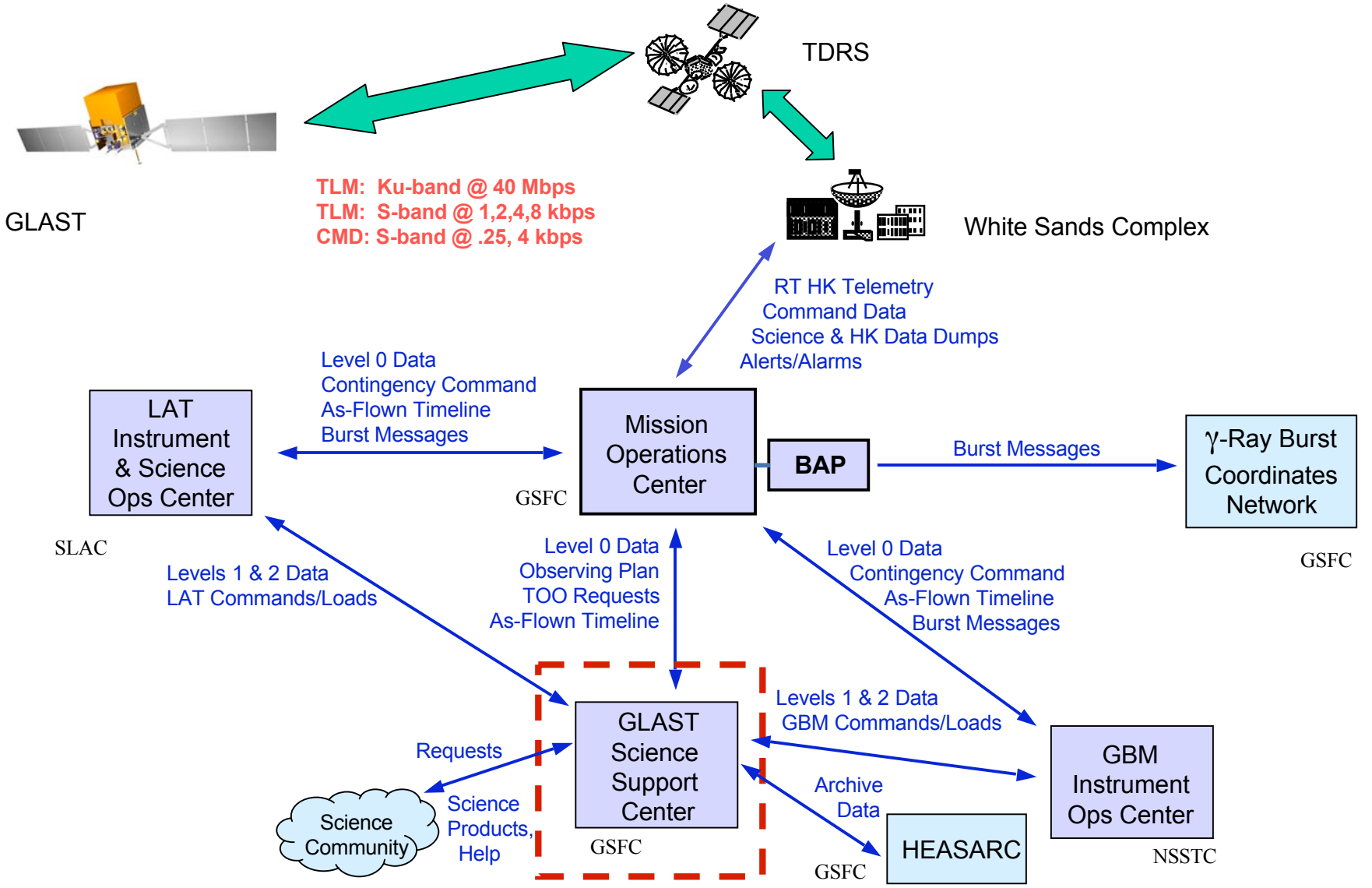
- Level 0—the cleaned-up telemetry: packets are time-ordered; repeated packets are removed; packet accounting information recorded
- Level 1—data processed by the instrument teams and ready for astrophysical analysis. LAT events are reconstructed, characterized as photon/non-photon, and described physically {energy, arrival time, origin, …}.
- Level 2—results of routine data analysis, e.g., spectral fits.
- Level 3—compendia of Level 2 data, e.g., catalogs.
- Ancillary data—the astrophysical analysis will require a model of the diffuse background, and a database of pulsar ephemerides.

Mission Phases

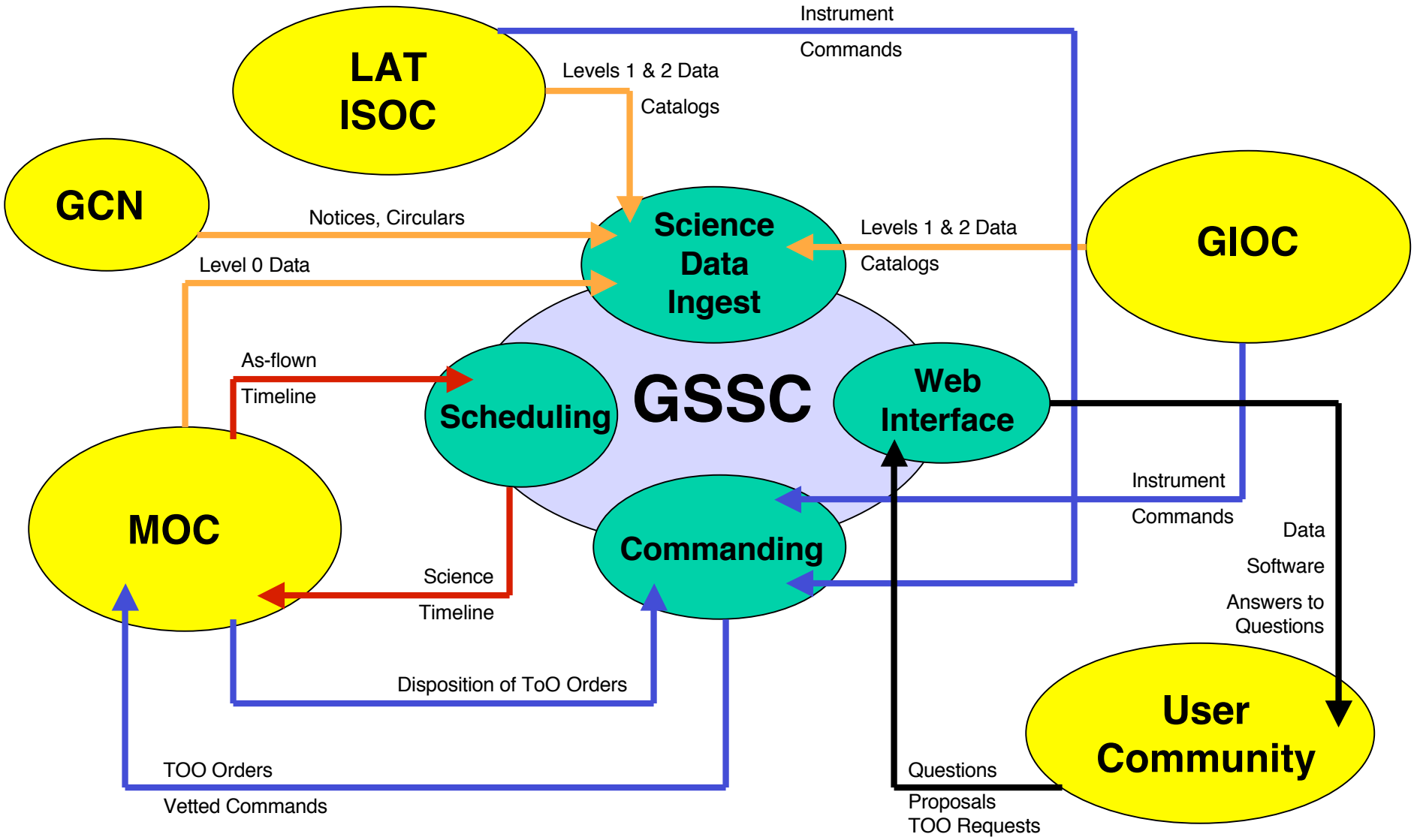
- The mission has 3 phases:
  - Phase 0—the ~ 60 day checkout period after launch
  - Phase 1—the 1 year sky survey while instrument teams calibrate their instruments. Except for observations of transients, the data are restricted to the instrument teams and a small number of guest investigators.
  - Phase 2—the rest of the mission until deorbit. The GI program drives the observations; however, simulations predicate that survey mode is still expected to predominate.

- Yearly GI cycles; Cycle 1 will coincide with Phase 1.
  - Cycle 1: approximately one dozen GIs will be selected.
  - Subsequent cycles: approximately 100 GIs per cycle.

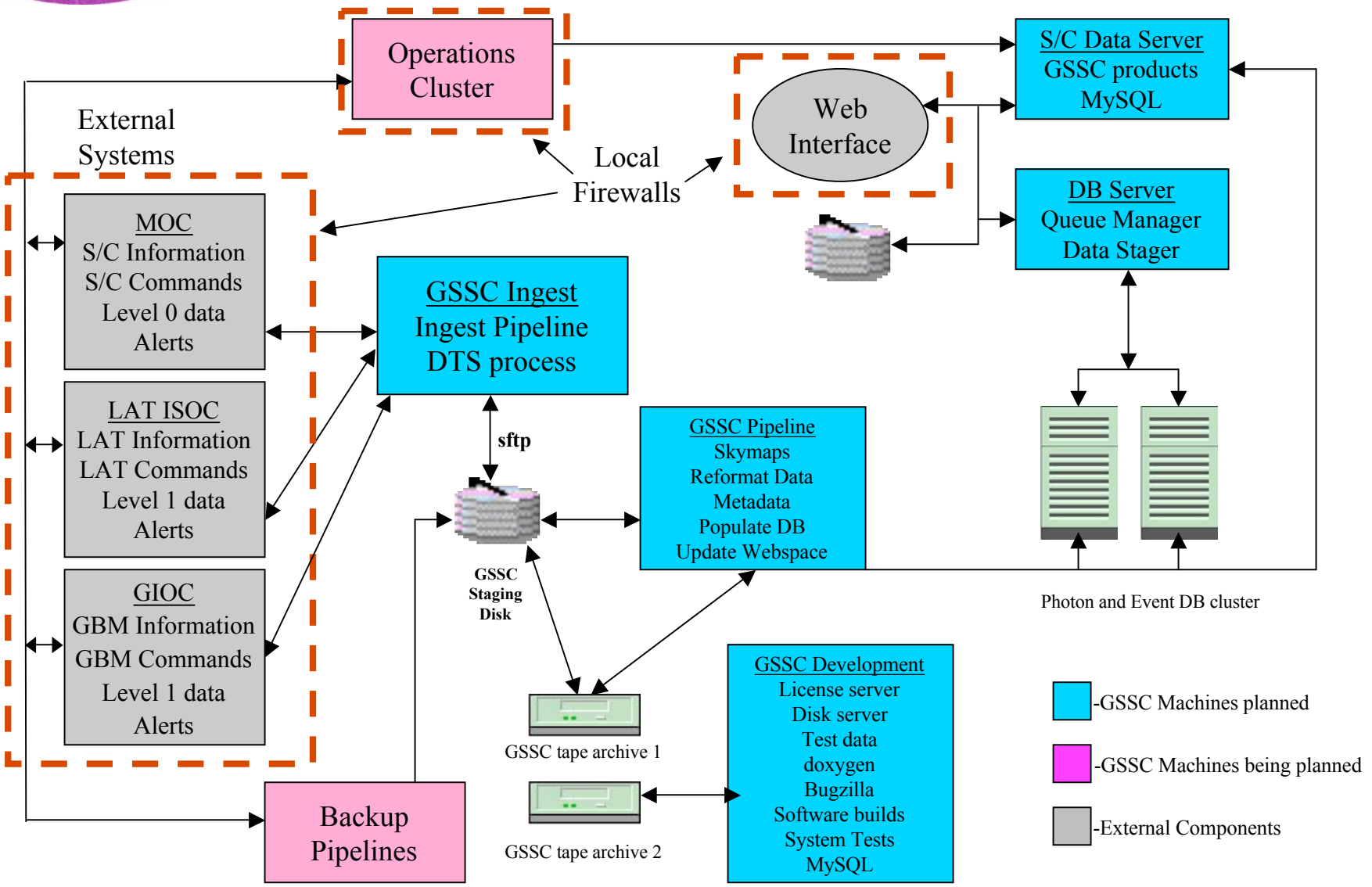
Mission Architecture



GSSC-Centric Communications / Data Flow



GSSC Computer Architecture



Δ's on Requirements, Design

- No Italian mirror site for GSSC to support
- Addition of "Ku" band necessitates preparation of timeline one month in advance.

RFA's From First Peer Review

#	Author	Topic	Addressed
1	Marshall, Schweiss	Independent future GSSC Reviews	II – Development
2	Marshall	FTOOLs issues to resolve: multiplatform support, duplication of release	VI – User Sup. VII – SW Dev.
3	Marshall	Location of computers: BAP and GSSC operations	III – Ops
4	Marshall, Henegar	End-to-end data tracking system	(Passed to GS)
5	Digel	DTS concerns of LAT team	III – Ops
6	Rioux	Review Security Guidelines	(Passed to GS)
7	Marshall, Schweiss	Duplication of Level 0 archiving	V – Databases
8	Marshall, Rioux, Corcoran, Schweiss	Incomplete requirements on GSSC: SSC changing timeline, orphan requirements	II – Development VI – User Sup.
9	Paciesas, Shrader	Need formal software test plan and schedule, with independent test manager	VII – SW Dev.
10	Paciesas	Need trade studies schedule, etc.	III – Ops
11	Paciesas	GSSC products need ITAR review	II – Development
12	Shrader, Boyd, Digel	Archive interface HEASARC issues, which databases archived?	VII – SW Dev.
13	Boyd, Shrader	GI support issues: schedule is tied to delivery of software and calibration products, helpdesk response time, PIMMS for simulation	VI – User Sup.
14	Corcoran	Data staging disk space concern	V – Databases
15	Corcoran, Marshall	Database concerns: Tracking photons by processing version, data staging disk space sufficient for many large queries?	V – Databases
16	Shrader, Boyd	Two stage review is unnecessary	VI – User Sup.
17	Digel	Plan for proprietary data contingency	V – Databases
18	Rioux	Verification Reference Handbook	(Withdrawn)
19	Schweiss	Ops Info Missing: Concept Document, Staffing Requirements, Users Guide	III – Ops

RFA's Ordered by Section

#	Author	Topic	Addressed
1	Marshall, Schweiss	Independent future GSSC Reviews	II – Development
8	Marshall, et al.	Incomplete requirements on GSSC: SSC changing timeline, orphan requirements	II – Development
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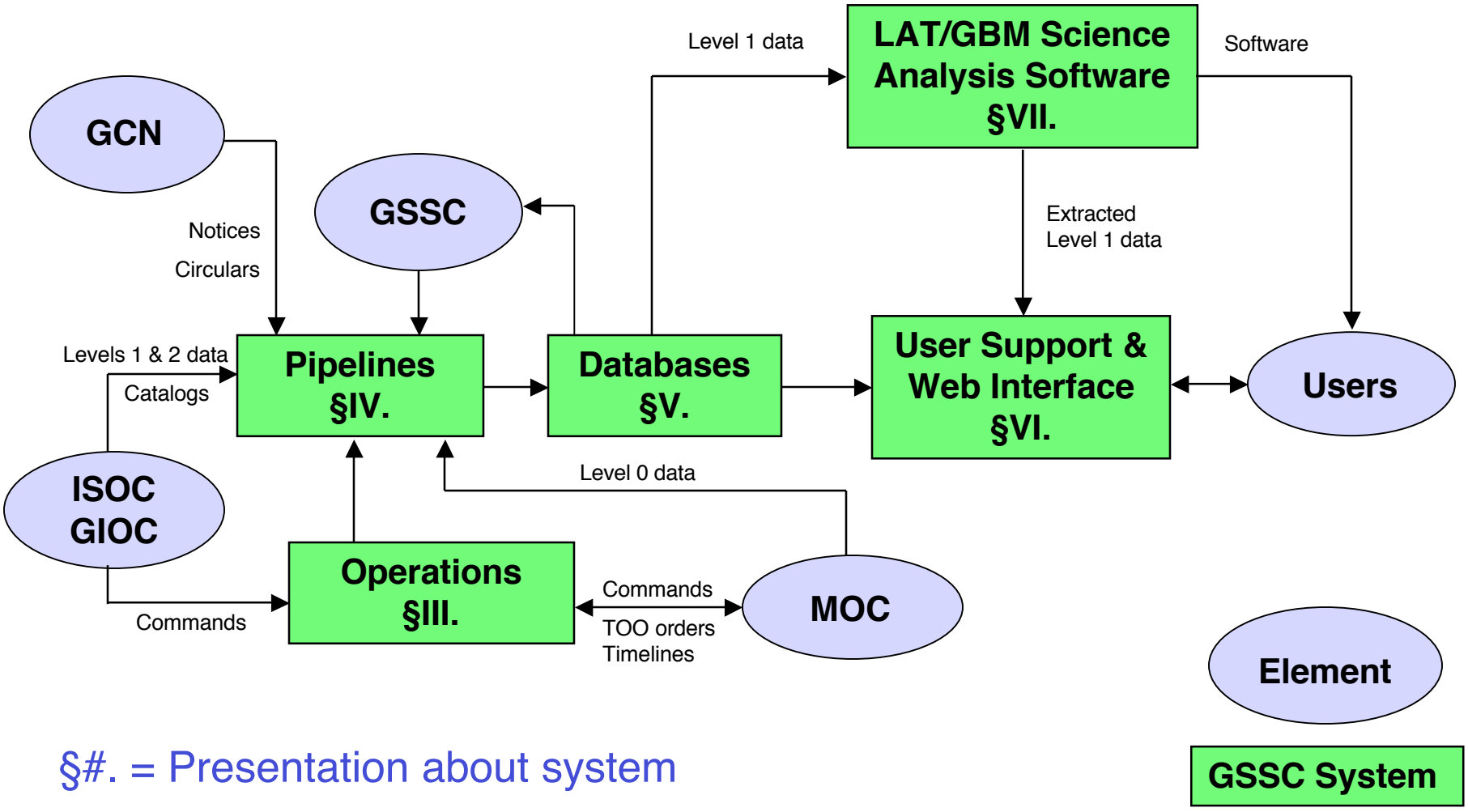
Outline of Presentations

Review Section	Presenter	Time	Interval	N_{VGs}
I. Overview	– J. Norris	9:00	(0:25)	20
II. GSSC Development	– J. Norris	9:25	(0:35)	21
III. Operations	– R. Corbet	10:00	(1:00)	46
IV. Pipelines	– T. Stephens	11:00	(0:25)	27
V. Databases (1)	– D. Davis	11:25	(0:35)	28
*** Lunch ***		12:00	(0:30)	
Databases (2)	– D. Davis	12:30	(1:30)	50
VI. User Support	– D. Band	14:00	(0:45)	51
VII. SW Development	– R. Schaefer	14:45	(1:30)	57
VIII. Summation	– J. Norris	16:15	(0:05)	3
*** Done ***		16:20	total = 303	

GSSC Software Systems



§#. = Presentation about system